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(54) Title: SINTERING AN IRON ORE BLEND CONTAINING POROUS ORES

(57) Abstract

A process for sintering an iron ore blend of iron ore particles, the iron ore blend comprises soft/porous ores is disclosed. The process comprises forming a green mix of the iron ore blend and a flux; granulating the green mix with water; and sintering the granulated green mix. The process is characterised by a treatment step to inhibit absorption of water into the soft/porous ores.

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# SINTERING AN IRON ORE BLEND CONTAINING POROUS ORES

The present invention relates to sintering an iron ore blend.

The present invention relates particularly to sintering an iron ore blend containing porous reactive ores, such as pisolite ore.

The term "sintering" as used herein in relation to an iron ore blend describes a process whereby a green mix of iron ore particles, fluxes (e.g. limestone, dolomite, and serpentine), fuel, and plant fines (eg. mill scale, blast-furnace dust, and returned sinter fines) are converted into an agglomerate called "sinter". The process comprises the following basic steps:

(i) granulation of the green mix with water at room temperature to form granules comprising a relatively large core or nucleus of particles coated with a layer of finer adhering material;

(ii) charging the granules onto a strand to form a bed;

(iii) ignition of the surface of the bed;

(iv) sequential combustion of the fuel in horizontal layers down the bed, generating heat which is sufficient to cause a liquid melt to form from the adhering fines layer of the granules;

(v) reaction at high temperatures involving

the liquid melt and the cores or nuclei of the granules resulting in partial dissolution of the solids;

(vi) cooling and solidification of the liquid melt; and

(vii) crushing.

The international iron ore trade has been dominated for several decades by high-grade, relatively dense predominantly hematite ($Fe_2O_3$) ores (hereinafter referred to as "hematite ores") from Australia, Brazil, and India.

The hematite ores are formed from banded iron formations - ferruginous sedimentary rocks that consist of fine, alternating layers of magnetite and quartz - by natural enrichment during geological time. The enrichment process involves the removal of silica and addition of iron to produce large hematite ore bodies, many of which have a very high iron grade.

The fluxes used in sintering blends of hard/dense hematite ores typically comprise limestone, dolomite and serpentine. In accordance with the usual practice, for optimum sinter plant productivity, the particle size distribution of the fluxes is selected to be minus 3 mm with a considerable proportion of the particles being minus 1 mm material.

The Pilbara region of Western Australia has considerable reserves of porous reactive iron ores, which are softer and more porous than hematite ores, and increasingly the porous reactive iron ores are being included in iron ore blends with the hard/dense hematite iron ores.

The porous reactive ores (hereinafter referred to as "soft/porous ores") include (a) pisolite ore, such as Yandi ore, which is composed predominantly of goethite (FeO.OH) with only minor amounts of hematite; (b) porous hematite ores, such as from certain parts of the Carajas mine in Brazil; and (c) hematite-goethite ores such as Marra Mamba ore.

Specifically, in relation to iron ores in Australia, soft/porous ores include class 5, 6 and 7 ores under the classification in a paper "Pilbara iron ore classification - a proposal for a common classification for BIF derived supergene iron ore" Proc Australas, Ins. Min. Min. Metall., No. 289, June/July 1984, 157-162.

It has been found that the primary problem with soft/porous ores, currently mined in significant quantities, is that they reduce sinter plant productivity. It is also widely believed that soft/porous ores cause sinter plant yield to deteriorate.

The conventional view is that the reduction in productivity is due to the soft/porous ores reacting/assimilating readily to form large melt volumes and thereby reducing the permeability of the high temperature zone of the sintering bed and increasing substantially the sintering time required to complete steps (iv) and (v) noted above. The reduction in yield is normally attributed to increased localised melt formation (over-melting) causing diminished airflow through the sintering bed and in localised lower regions resulting in unsintered material.

However, research carried out by the applicant does not support the foregoing conventional view but rather supports the view that the observed reduction in sinter plant productivity is due to soft/porous ores absorbing a

significant proportion of the water added during the granulation process which would otherwise be available for inter-particle adhesion. Specifically, the increased water absorption causes a reduction in green bed permeability. The research is discussed in the papers "Sintering iron ore blends containing Yandi pisolitic limonite using coarser fluxes" 6th International Symposium on Agglomeration 1993, 267-272, and "Improving sintering performance of ore blends containing pisolite ore, 'Trans. Instn Min. Metall. (Sect. C: Mineral Processing Extra. Metall) 103, May - August 1994.

Against the foregoing disadvantage of reduced sinter plant productivity, it has been found that sinter formed from blends of soft/porous ores and hematite ores have the advantages of improved reducibility and low-temperature reduction degradation index compared with sinter formed from blends of hematite ores only. The improved reducibility is thought to be due to the soft/porous ores forming a sinter of increased porosity and containing fine hematite grains.

There have been a number of proposals for improving sinter plant productivity for blends of soft/porous ores, in particular pisolite ore, with hematite ores.

By way of example, Japanese patent 58-55221 entitled "Method of Pre-processing Sinter Raw Materials" in the name of Nippon Steel Corporation and Nisshin Steel Technical Report 1988, December, No. 59, 68-75 entitled "Increase of Sinter Productivity by Pre-granulation Process" proposes coating the surface of particles of pisolite ores with serpentine prior to granulation with hematite ores and other components to form a green mix. The purpose of the serpentine coating is to alter the assimilation behaviour of the pisolite ore particles during

sintering and thereby improve sinter plant productivity.

Further, Japanese patent 58-141341 entitled "Preliminary Treating of Ore containing Limonite for Sintering" in the name of Nippon Steel Corp. proposes coating the surface of particles of pisolite ores with fine ores (greater than 80% of the fine ore particles less than 0.25 mm) prior to granulation with other components to form a green mix. The purpose of the fine ore coating on the pisolite ore particles is to alter the assimilation behaviour of the pisolite ore particles during sintering and thereby improve sinter plant productivity.

Further, the papers "Plant sintering performance with high proportion of pisolitic limonite ore" 6th International Symposium on Agglomeration 1993 pgs. 255-260, and "Operation with high blending ratio of pisolite ore at Kobe Works" 1st Int. Congr. on Sci. and Tech. of Ironmaking 1994 propose increasing water addition during granulation to compensate for the increased water absorption by soft/porous ores. However, this is not a good technique as pisolite ore already contains significant water because of its goethite content. A high water load in a sinter plant causes a lowering of exhaust gas temperatures, increased load on the fans, and, possibly, condensation in the wind legs and deterioration in electrostatic precipitator performance. Increased water addition during granulation also results in the formation of a "very wet" moisture condensation zone, which is ahead of the high temperature formation zone, during sintering. This could have an adverse influence on the permeability of the moisture condensation zone, the breakdown of granules in the moisture condensation zone and, consequently, the permeability of the sintering bed and the airflow distribution through the bed during sintering.

An object of the present invention is to provide

a process of sintering iron ore blends containing soft/porous ores to achieve higher sinter plant productivity to a productivity level up to or better than that obtained using known processes of sintering iron ore blends containing predominantly hematite ores.

According to the present invention there is provided a process for sintering an iron ore blend of iron ore particles, the iron ore blend comprising soft/porous ores, the process comprising:

(a) forming a green mix of the iron ore blend and a flux;

(b) granulating the green mix with water; and

(c) sintering the granulated green mix,

the process being characterised by a treatment step to inhibit absorption of water into the soft/porous ores.

The present invention is based on the realisation that it is possible to incorporate soft/porous ores into iron ore blends without loss of sinter performance (measured by way of example by plant productivity) and sinter quality (measured by way of example by sinter strength) by inhibiting absorption of water into the soft/porous ores.

The treatment step may be selected to alter the properties, such as viscosity, of the water used in granulation step (b).

Alternatively, the treatment step may be selected to alter the properties, such as the surface properties, of the soft/porous ores. For example, the treatment step may have the effect of blocking the pores of the soft/porous

ores.

Alternatively, the treatment step may be selected to seal the pores of the soft/porous ores.

The treatment step may be any other suitable step which inhibits absorption of water into the soft/porous ores.

It is preferred that the treatment step includes the addition of an additive which is selected to inhibit absorption of water into the soft/porous ores.

The additive may be any suitable material and includes, but is not limited to, starches, natural and synthetic gums, plant sugars and syrups, starch gums such as dextrin, by-products and wastes from sugar refineries such as molasses, animal and plant glues, gelatine, synthetic polymers such as polyelectrolytes, and substances such as polyethylene glycol, polyvinyl acetate, polyvinyl alcohol, and waxes.

It is preferred that the additive be one or more of sugar, sugar syrup, molasses, or compounds containing sucrose or invert sugar.

The additive may be added in any suitable manner and stage of the sintering process. By way of example, the additive can be:

(i) dissolved in the water used for granulation step (b);

(ii) added as a solid into the sinter mix formed in step (a);

(iii) used to pre-coat the iron ore particles,

prior to use in step (a); and

(iv) added in solid or liquid form to the sinter mix formed in step (a) at ore loading or discharge Ports or in stockpiles.

It is preferred that the additive be selected to act also as a binder to improve the adhesion of iron ore particles during granulation and/or the structural integrity of the granules in the different regions of a bed during sintering, such as in the drying zone and the moisture condensation zone of the bed.

The present invention, insofar as this aspect is concerned, is based on the realisation that if the additive also acts as a binder then further improvements in sintering performance may be obtained, particularly with iron ore blends containing soft/porous ores such as Yandi ores which are not particularly good adhering materials at room and higher temperatures.

It is preferred that the iron ore blend comprises more than 10 wt.% soft/porous ores.

It is preferred particularly, that the iron ore blend comprises more than 15wt.% soft/porous ores.

It is preferred more particularly that the iron ore blend comprises more than 20 wt.% soft/porous ores.

The present invention is described further hereinafter by reference to a series of sinter tests and plant trials carried out by the applicant.

The sinter tests involved the sintering of a range of iron ore blends to determine if sugar-based

compounds could retard the rate of absorption of water by soft/porous ore in the blends to produce, on a pilot plant scale, reductions in water requirements during granulation, improvements in granulation performance, sinter productivity, and sinter quality.

The sinter tests were carried out using a pilot-plant sinter pot sintering facility at the Newcastle Laboratories of the applicant. The sinter pot used had an area of 0.09 $m^2$ and was operated with a material bed height of 500 - 530 mm. The total granulated mix charge weight for each sinter test was approximately 70 kgs. The sintering facility and operating parameters are described in detail in a paper entitled "Positioning coke particles in iron ore sintering" by C.S. Teo, R. Mikka and C.E. Loo published in ISIJ Int. 32, 10, 1992, 1047-1057, and the disclosure in the paper is incorporated herein.

The sinter tests were carried out on:

(a) a sinter mix of a base iron ore blend containing no soft/porous ores (the "base blend"), as a reference; and

(b) 3 sinter mixes containing significant amounts of soft/porous ores - these sinter mixes being referred to in the following description as Yandi blends 1, 2, and 3.

The base blend contained hematite ores that were selected on the basis of chemical composition and in suitable proportions to achieve a target sinter chemical composition of: 51.46% Fe; 5.07% $SiO_2$; 1.84% $Al_2O_3$; 10.13% CaO; and 1.55% MgO. The basicity of the base blend and Yandi blends 1, 2, and 3 was kept at 2.0.

Table 1 provides information on the base blend and the Yandi blends 1, 2, and 3.

Table 1 Ore blends

| Blends | Base blend | Yandi 1 | Yandi 2 | Yandi 3 |
|---|---|---|---|---|
| Mt Newman primary | 50.0 | 10.0 | 11.1 | 18.0 |
| Mt Newman secondary | 16.0 | 16.0 | 6.8 | 7.2 |
| Yandi | - | 40.0 | 22.2 | 35.9 |
| Koolan | 30.0 | 30.0 | - | - |
| Whyalla blended fines | 4.0 | 4.0 | 15.6 | - |
| Yarrie fines | - | - | 28.6 | 28.7 |
| Manganese fines | - | - | 0.9 | 1.2 |
| Brazilian ore | - | - | 3.2 | - |
| Tasmanian magnetite | - | - | 2.6 | - |
| Other plant fines | - | - | 9.0 | 9.0 |
| | | | | |
| Sinter basicity | 2.0 | 2.0 | 2.0 | 2.0 |
| Sinter MgO | 1.55 | 1.55 | 1.5 | 1.5 |
| Dolomite:serpentine weight ratio | 0.66:0.34 | 0.66:0.34 | 0.64:0.36 | 0.64:0.36 |

In summary, the aim of the sinter tests was to obtain a return fines balance of between 0.95 and 1.05.

In each sinter test a sinter mix of around 100 kg of iron ore and fluxes was granulated in a batch granulation drum of 1.1 m in diameter.

The granulation process involved the addition of:

(a) water, as a reference; or

(b) 5 wt.% sugar solution; or

(c) 10 wt.% sugar solution; or

(d) 10 wt.% molasses.

In each experimental run, the granulating liquid was added onto the base blend and the Yandi blends as sprays as the blends cascaded in the drum. After 10 minutes of granulation, the drum was tilted and the charge emptied directly into a hopper.

The standard method for loading the sinter pot involved placing the hopper directly above the sinter pot and opening the sliding valve at the bottom of the hopper to discharge its contents. A straight edge was then used to level the bed. The conditions used for sintering are summarised in Table 2.

Table 2 Sinter test conditions

| | |
|---|---|
| Ignition temperature | 1200°C |
| Ignition suction | 6kPa |
| Ignition time | 1.5 min. |
| Sintering suction | 16kPa |
| Cooling | Downdraft at 16kPa |
| Shatter for stabilisation | Four drops from 2 m |
| Sinter product | + 6.4 mm |

It can be seen from Table 1 that the only difference between the compositions of the base blend and Yandi blend 1 is that the Yandi blend 1 contains 40 wt.% Yandi ore and only 10 wt.% Mt Newman primary ore and the

base blend contains 50 wt.% Mt Newman primary ore and no Yandi or any other soft/porous ore. As a consequence, a comparison of the results of the sinter tests for the base blend and the Yandi blend 1 provides a good basis to assess the present invention. In addition, the compositions of the Yandi blends 2 and 3 are quite different from the Yandi blend 1 and the results of the sinter tests for these blends provide a good basis to assess the effect of sugar on a range of iron ore blends containing soft/porous ores.

In the circumstances, the results of the sinter tests for the base blend and Yandi blend 1 are summarised in Table 3 and for Yandi blends 2 and 3 are summarised in Table 4.

<u>Table 3</u> Sintering results for base blend and Yandi blend 1 (Yandi ore moisture in 6%)

| Blend | Mix moisture (%) | Return fines in mix (%) | Sintering time (min) | Productivity ($t/m^2d$) | Coke rate (kg/t) | Tumble index (% 6.3 mm) | Return fines balanc |
|---|---|---|---|---|---|---|---|
| B(W) | 5.53 | 50 | 18.1 | 43.5 | 66.0 | 63.2 | 0.97 |
| 1(W) | 5.54 | 55 | 19.6 | 38.0 | 67.6 | 66.2 | 0.95 |
| B(10S)-G | 5.52 | 60 | 16.9 | 46.8 | 65.9 | 64.4 | 0.92 |
| 1(10S)-G | 5.49 | 55 | 14.9 | 51.0 | 67.0 | 66.6 | 0.96 |
| 1(10S)-G | 5.31 | 55 | 16.1 | 48.3 | 66.6 | 67.5 | 0.91 |
| 1(10S)-G | 5.14 | 55 | 17.5 | 43.6 | 67.5 | 68.6 | 0.95 |
| 1(10S)-D | 5.69 | 47.5 | 18.2 | 43.6 | 64.9 | 67.9 | 0.96 |
| 1(10S)-S | 5.47 | 47.5 | 17.4 | 45.8 | 67.2 | 68.6 | 0.95 |
| 1(10S)-C | 5.80 | 47.5 | 17.2 | 46.2 | 59.1 | 69.2 | 0.96 |
| 1(5S)-G | 5.67 | 50 | 17.5 | 44.7 | 67.1 | 67.0 | 0.94 |
| 1(10M)-G | 5.71 | 47.5 | 18.4 | 43.0 | 68.9 | 67.6 | 0.97 |

<u>Notation</u>

First letter - B: base blend i.e. no Yandi; 1: Yandi blend, i.e. 40 % of an ore in the base blend substituted with Yandi (pisolite ore)
In parenthesis - 10S: 10% sugar solution or the equivalent in mass, 5S:5% sugar solution or the equivalent in mass, W: water; 10M: 10% molasses solution
Last letter - G: Added in water to granulating drum; D: Added in dry with ores; S: Yandi or drenched in solution before mixing with the other ores and water used in granulation; C: Coat Yandi ore with fine solid sugar before granulation.

Table 4 Sintering results for blends 2 and 3 (Yandi ore moisture -6.0%)

| Blend | Mix moisture (%) | Return fines in mix (%) | Sintering time (min) | Productivity ($t/m^2.d$) | Coke rate (kg/t) | Tumble index (% -6.3mm) | Return fines balance |
|---|---|---|---|---|---|---|---|
| 2(W) | 6.01 | 50 | 17.2 | 43.2 | 65.3 | 61.5 | 1.03 |
| 2(10S)-G | 5.99 | 50 | 14.7 | 52.8 | 64.0 | 61.9 | 0.98 |
| 2(10S)-G | 5.60 | 50 | 16.3 | 47.6 | 63.5 | 63.1 | 0.97 |
| | | | | | | | |
| $2^{\#}$(10S)-G | 5.68 | 50 | 15.4 | 51.0 | 64.0 | 61.1 | 0.97 |
| 3(W) | 5.96 | 50 | 19.7 | 38.0 | 69.0 | 63.8 | 0.98 |
| 3(10S)-G | 5.89 | 50 | 14.6 | 50.0 | 64.1 | 61.6 | 0.99 |

Notation

First letter - 2: Blend 2 which has ~25% Yandi in ore mix; 3:Blend 3 which has ~40% Yandi in ore mix; superscript #indicates that the Yandi sample used has been oven-dried
In parenthesis - 10S: 10% sugar solution or the equivalent in mass, 5S: 5% sugar solution; W:water
Last letter - G: Added in water to granulating drum

Table 3 shows that, at a mix moisture of around 5.5% and no sugar addition, the use of Yandi ore instead of Mt Newman primary ore in Yandi blend 1 resulted in a significant decrease in productivity from around 44 to $38t/m^2/day$.

Table 3 also shows that the use of a 10% sugar solution to replace granulation water has a very beneficial influence on the sintering of a blend containing Yandi ore. At the same mix moisture of around 5.5% the use of sugar solution in place of water for granulation greatly shortened sintering time and increased productivity from 38 to around 50 $t/m^2/day$. The table shows that the use of sugar solution has some benefit on the base blend but the increases in sintering performance were not as dramatic, from around 43 to $47t/m^2/$ day.

Table 3 also shows that there are other benefits in using a sugar solution on the sintering of the Yandi blend. It is to be noted that even at a high productivity of around $51t/m^2/day$ the strength of the sinter (measured by the tumble index) produced from Yandi blend was still comparable to that obtained from Yandi blend using 5.5% water only (i.e. Blend 1) and higher than that for the base blend, which means that coke rate would be reduced during sintering for the same sinter strength.

Table 3 also suggests that, if high productivity is not required, the mix moisture can be reduced to around 5.1% and a substantial coke saving obtained since the sinter is very much stronger than the base case - ISO tumble index of around 69 compared to 63.

Table 3 also shows that a 5% sugar solution used with Yandi blend 1 increased productivity to levels comparable to the base blend and, at the same time, produced a stronger sinter.

Table 3 also shows that the sugar can be added by methods other than in the granulation water. For example, the table shows that adding the sugar in dry with the ore has benefits on productivity although the effect is not as pronounced as dissolving the sugar in the solution before use. Pregranulating or coating the Yandi particles with the sugar particles also has a significant influence on productivity. Again, the improvement in productivity was achieved together with very significant increases in sinter strength. The final method considered was drenching some (the plus 1mm fraction) of the Yandi ore in a 10% sugar solution before use. Ordinary tap water was used thereafter in the granulation process. Results indicate significant improvements in productivity and strength.

Table 3 also shows that molasses, a residual sugar syrup, is beneficial. Subsequent tests, not reported here, showed that because of its lower sugar content improved sintering performance was obtained at higher molasses levels. In addition, it was found that invert sugar is also effective in reducing moisture absorption by Yandi ore and in increasing productivity.

Table 4 shows that sugar significantly increases productivity on Yandi blends 2 and 3.

A range of other additives have also been tested with the view to altering the properties of water, such as viscosity, to inhibit absorption into soft/porous ores. Substances such as starches, polymers (e.g. polyacrylamides), dextrin and gums - at appropriate levels - all influenced the sintering process but to varying degrees. Most did have some positive influence on productivity (i.e. giving productivities of greater than $38t/m^2/day$ at a mix moisture of around 5.5%) but not to the same level of sugar. But in almost every case their introduction into the process led to the production of a

much stronger sinter at the same moisture level because energy was not expended in removing the additional water. The results also indicate that coke rates could be decreased significantly without causing sinter strength to drop below the base case value of around 64.

Following the completion of the sinter tests described above, the applicant carried out a series of plant trials at the sinter plant at the Slab and Plate Products Division of the applicant at Port Kembla, NSW.

The plant trials were carried out on a sinter mix containing 36.06 wt.% Port Hedland fines which is a blend of 65 wt.% Yandi and 35 wt.% Mt Newman fines. Therefore, the level of Yandi ore in the sinter mix is around 24 wt.%. The composition of the sinter mix is set out in Table 5.

Table 5

| BLENDER FEED | BLEND |
|---|---|
| Port Hedland fines | 36.06 |
| Yarrie P fines | 19.07 |
| Whyalla fines | 14.64 |
| M.B.R. | 7.98 |
| Mt Newman secondary fines | 5.00 |
| Sinter fines U/S | 2.75 |
| Carol Lake | 2.40 |
| Tasmania magnetite | 2.09 |
| ASMS sinter fines | 1.07 |
| MBR secondary fines | 1.04 |
| Flue dust, BOS metallics, Filter cake, Dedusting slurry, Millscale, Endcone | 5.40 |
| Yarrie secondary fines | 1.00 |
| Ore fines mixed | 0.93 |
| Dolomite kiln flux | 0.58 |
| TOTAL BLEND | 100.00 |

One part of the sinter mix (the "trial sinter mix") was prepared with a sugar solution and the remainder of the sinter mix (the "base sinter mix") was prepared without the addition of sugar. Details of the green bed properties, sinter plant operations, and sinter quality are set out in Tables 6, 7, and 8, respectively.

Table 6 Green bed properties

| | Units | Trial | Base | Difference |
|---|---|---|---|---|
| GREEN BED | | | | |
| Permeability | JPU | 37.0 | 33.9 | +3.1 |
| Mix moisture | % | 5.73 | 5.47 | -0.26 |
| QUASI PARTICLES | | | | |
| Mean size | mm | 3.01 | 2.93 | +0.08 |
| Harmonic mean size | mm | 0.98 | 0.86 | +0.12 |

Table 7 Sinter Plant Operations

| | Units | Trial | Base | Difference |
|---|---|---|---|---|
| Productivity | t/d.m2 | 35.4 | 32.2 | +3.2 (+10%) |
| Coke rate | kg/t-s | 51.3 | 50.3 | +1.0 |
| Gas rate | Nm3/t-s | 1.53 | 1.65 | -0.12 |
| Return fines | %machine feed | 20.4 | 18.7 | 1.7 |
| Bed height | mm | 545 | 539 | +6 |
| Flame front speed | mm/min | 24.2 | 22 | +2.2 |
| Mix moisture | % | 5.8 | 5.9 | -0.1 |

Table 8 Sinter Quality

| | Units | Trial | Base | Difference |
|---|---|---|---|---|
| Mean size | mm | 16.2 | 16.8 | -0.6 |
| +5mm | % | 93.7 | 94.2 | -0.5 |
| Tumble index | % + 10mm | 64.5 | 65.4 | -0.9 |
| RDI | % - 3mm | 36.8 | 39.1 | -2.3 |
| RI | % reduction | 63.7 | 63.9 | -0.2 |

With reference to the Tables 6, 7 and 8, an interesting result of the sinter plant trials is that the green bed permeability of the trial sinter mix was 3.1% higher than that of the base sinter mix with only a marginal difference in mix moisture requirements. This result indicates that sugar had a beneficial effect on granulation.

Another interesting result of the sinter plant trials is that the trial sinter mix enabled a 10% increase in productivity of the sinter plant (Table 7) with the sinter being of comparable quality to that of the base sinter mix (Table 8).

In quantitive terms the results of the sinter plant trials were not as good as the results of the sinter tests. This was due to particular equipment factors and the applicant believes that, under normal circumstances, significantly better results would be achieved in a sinter plant.

In summary, the sinter plant trials confirmed the beneficial results of the sinter tests.

Many modifications may be made to the present invention as described above without departing from the spirit and scope of the present invention.

CLAIMS:

1. A process for sintering an iron ore blend of iron ore particles, the iron ore blend comprising soft/porous ores, the process comprising:

(a) forming a green mix of the iron ore blend and a flux;

(b) granulating the green mix with water; and

(c) sintering the granulated green mix,

the process being characterised by a treatment step to inhibit absorption of water into the soft/porous ores.

2. The process defined in claim 1 wherein the treatment step comprises altering the properties, such as viscosity, of the water used in granulation step (b).

3. The process defined in claim 1 or claim 2 wherein the treatment step comprises altering the properties, such as the surface properties, of the soft/porous ores.

4. The process defined in any one of the preceding claims wherein the treatment step comprises sealing the pores of the soft/porous ores.

5. The process defined in any one of the preceding claims wherein the treatment step comprises adding an additive which is selected to inhibit absorption of water into the soft/porous ores.

6. The process defined in any one of the preceding claims wherein the treatment step comprises adding an additive which is selected to inhibit absorption

of water into the soft/porous ores and to act as a binder during granulation and/or during sintering.

7. The process defined in claim 5 or claim 6 wherein the additive comprises any one or more of starches, natural and synthetic gums, plant sugars and syrups, starch gums such as dextrin, by-products and wastes from sugar refineries such as molasses, animal and plant glues, gelatine, synthetic polymers such as polyelectrolytes, and substances such as polyethylene glycol, polyvinyl acetate, polyvinyl alcohol, and waxes.

8. The process defined in any one of claims 4 to 7 wherein the additive comprises one or more of sugar, sugar syrup, molasses, or compounds containing sucrose or invert sugar.

9. The process defined in any one of claims 4 to 8 wherein the treatment step comprises dissolving the additive in the water used in granulation step (b).

10. The process defined in any one of claims 4 to 8 wherein the treatment step comprises adding the additive as a solid into the sinter mix formed in step (a).

11. The process defined in any one of claims 4 to 8 wherein the treatment step comprises pre-coating the iron ore particles with the additive prior to use in step (a).

12. The process defined in any one of claims 4 to 8 wherein the treatment step comprises adding the additive in solid or liquid forms to the sinter mix formed in step (a) at ore loading or discharge Ports or in stockpiles.

13. The process defined in any one of the

preceding claims wherein the iron ore blend comprises more than 10 wt.% soft/porous ores.

14. The process defined in claim 13 wherein the iron ore blend comprises more than 15wt.% soft/porous ores.

15. The process defined in claim 14 wherein the iron ore blend comprises more than 20 wt.% soft/porous ores.

# INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 95/00408

**A. CLASSIFICATION OF SUBJECT MATTER**

Int Cl$^{6}$: C22B 1/16

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC C22B 1/16, 1/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DERWENT: IPC as above and (Absorb: or poro:)
JAPIO: IPC as above

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | Patent Abstracts of Japan, C-346, page 63, JP 60-255935 A (SHIN NIPPON SEITETSU K.K.) 17 December 1985 | 1-15 |
| A | Patent Abstracts of Japan, C-360, page 48, JP 61-44135 A (NIPPON KOKAN K.K.) 3 March 1986 | 1-15 |
| A | Patent Abstracts of Japan, C-361, page 73, JP 61-48536 A (NISSHIN STEEL CO LTD) 10 March 1986 | 1-15 |

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
5 October 1995

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13 OCTOBER 1995

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| C (Continuation) | DOCUMENTS CONSIDERED TO BE RELEVANT | |
|---|---|---|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| A | Patent Abstracts of Japan, C-69, page 164, JP 56-72135 A (SUMITOMO KINZOKU KOGYO K.K.) 16 June 1981 | 1-15 |
| A | Patent Abstracts of Japan, C-127, page 90, JP 57-104610 A (JIYUUSHITSUYU TAISAKU GIJUTSU KENKIYUU KUMIAI) 29 June 1982 | 1-15 |
| A | Patent Abstracts of Japan, C-197, page 10, JP 58-147524 A (KAWASAKI SEITETSU K.K.) 2 September 1983 | 1-15 |
| A | Derwent Abstract Accession No. 58493Y/33, Class M24, JP 52-080202 A (NIPPON STEEL CORP) 5 July 1977 | 1-15 |

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International Application No.
**PCT/AU 95/00408**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| Patent Document Cited in Search Report | | Patent Family Member | | | |
|---|---|---|---|---|---|
| JP | 52-080202 | DE | 2652548 | US | 4129374 |
| | | | | | END OF ANNEX |